Name of the Student:_____
Max. Marks : 20 Marks **Time : 20 Minutes**

Q1.

Radioisotope thermoelectric generators (RTGs) are electrical generators powered by radioactive decay. As a radioisotope decays some of the energy released is converted into electricity by means of devices called thermocouples. In this way RTGs have been used as power sources in satellites, space probes and heart pacemakers.

The Cassini space probe was launched in 1997. It carried three RTGs each containing 11 kg of a nuclear fuel, plutonium oxide (a compound having two oxygen atoms combined with every plutonium-238 atom). In 1997, when the probe was launched, the power released from one gram of plutonium oxide was 500 mW.

Plutonium-238 $^{238}_{94}Pu$ is an alpha emitter, decaying into uranium(U).
The half-life of the decay is 87.7 years.

mass of one mol of plutonium-238 = 238 g
mass of one mol of oxygen atoms = 16 g

(a) State and explain why environmentalists might have been concerned by the use of such a large quantity of plutonium-238.

_____

_____

_____

_____

_____

(2)

(b) State and explain whether the activity of a given number of atoms of plutonium is affected when they are in the form of plutonium oxide.

_____

_____

_____

(2)

(c) (i) Calculate the decay constant, in s^{-1}, for plutonium-238.

_____

decay constant _____ s^{-1}

(2)

(ii) Calculate the number of plutonium-238 atoms in the total mass of the plutonium oxide in the Cassini probe at the beginning of its mission.

number of plutonium-238 atoms _____

(5)

(iii) Calculate the initial activity of the plutonium-238 in the Cassini probe.
Give a suitable unit for your answer.

initial activity of plutonium-238 _____ unit _____

(3)

(d) (i) Write a nuclear equation for the $\left(^{238}_{94}Pu\right)$ decay.

(2)

(ii) Assume the power released by the RTGs' fuel originated as the kinetic energy of the alpha particles emitted in the decay of $\left(^{238}_{94}Pu\right)$.

Calculate the maximum kinetic energy of each alpha particle.

_____

_____

_____

_____

_____

_____

_____

_____

kinetic energy of alpha particle _____ J

(4)

(Total 20 marks)